Evaluating zooplankton indicators for the MSFD food-web descriptor under environmental gradients and non-linear interactions - is there a universal indicator?

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The development of MSFD indicators is particularly challenging for descriptor 4 – food webs. Ideally, these indicators should signal the state of marine systems that are highly dynamic with complex and often non-linear interactions. Marine regions characterized by strong gradients, such as the Baltic Sea, imply additional complexity, as the relevance of indicators need to be known for the entire range of environmental conditions. In pelagic systems zooplankton can be useful indicators due to their pivotal role in mediating energy between trophic levels as well as their fast response to environmental changes. But the functional response of zooplankton to trophic and environment conditions might differ between areas making not every zooplankton indicator suitable as universal indicator for a broader region. Here, a robust testing of these indicators is necessary, accounting for their responsiveness to multiple pressures and ecosystem processes along the gradient of conditions. In this study we apply novel statistical models (i.e. threshold-formulations of Generalized Additive Models) to existing offshore monitoring data in the Baltic Sea. We specifically test the robustness of six potential zooplankton indicators and their responses to multiple pressures and non-linear interactions. The results show that most tested indicators respond to several pressures rather than single drivers and that responses often differ between sub-basins within the Baltic Sea. Threshold-formulations of models are often favoured over models without threshold dynamics, illustrating the usefulness of advanced modelling tools to fully capture relevant dynamics in systems characterized by different regimes.

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